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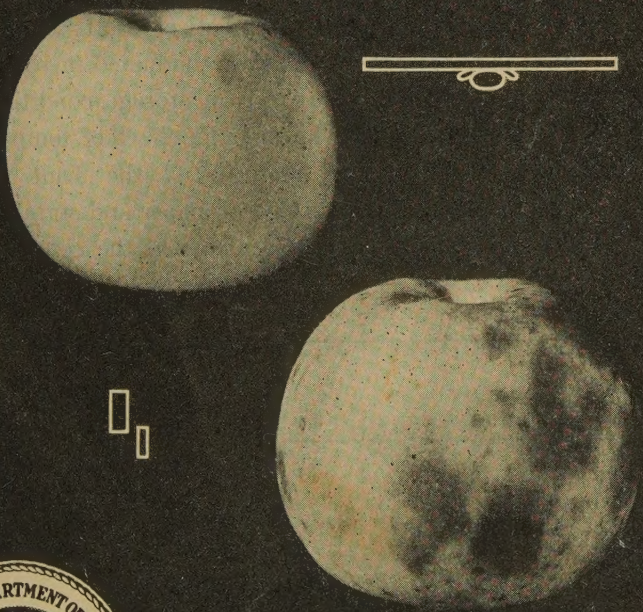
APPLE SCALD *and* ITS CONTROL



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SCALD is one of the most serious storage and market diseases of the apple and has an important bearing on all market operations during the latter half of the apple-storage season. The disease may appear while the apples are still in storage, but it makes its most rapid development after they have been removed from storage and exposed to the warmer air of the market or the home.

This bulletin gives a summary of the practical results obtained on scald control in a series of experiments conducted in various sections of the country under commercial storage conditions. It includes the results of tests showing the effect of temperature, aeration, delayed storage, maturity of the fruit, soil moisture, oiled wrappers, and shredded oil paper and states the relative merits of these different treatments in the control of scald.

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APPLE SCALD AND ITS CONTROL

By CHARLES BROOKS, *Principal Pathologist*, and J. S. COOLEY and D. F. FISHER, *Senior Pathologists, Office of Fruit Diseases, Bureau of Plant Industry*

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INTRODUCTION

Scald is a storage and market disease of apples. It is familiar to the dealer and the consumer, but may be practically unknown to the grower except as it affects the returns from his crop. Scald may appear on apples while still in commercial storage, but it is only after they have been moved to the warmer temperature of the market or the home that it makes its most rapid development. Apples may appear to be in perfect condition upon removal from storage and yet a few days later have their market value reduced 15 to 30 per cent or more on account of the development of scald. A disease that makes such a sudden appearance at a time when the apples are ready for consumption naturally has a very disturbing effect upon market operations, resulting in heavy losses and tending to limit distribution and decrease consumption.

APPEARANCE AND CHARACTERISTICS OF SCALD

In mild cases of scald the apple is merely tinted with brown, the skin remaining firm, but in more severe cases the skin tissue may be broken down to the extent that it sloughs off readily from the underlying flesh. In some instances the flesh becomes dead and brown to a depth of half an inch, and the disease takes on an appearance somewhat similar to that of apple rot; but true rot usually spreads down into the flesh in more or less conical shape, while scald affects a considerable area of the apple to a rather uniform but shallow depth. An apple that has had its skin killed by scald becomes the ready prey of the various rot organisms, and they soon finish the work of destruction that the scald has begun.

Scald differs from all other apple diseases in being more prevalent on the green side of the apple. Bright-red fruit surfaces are highly resistant to scald, and yellow surfaces are much more resistant than those that are green or that show the first stages of turning from green to yellow.

Apple scald is a nonparasitic or physiological disease. It is not brought about by the presence of foreign organisms, but is due to certain unfavorable conditions to which the apples are sometimes subjected. Seasonal and orchard conditions are involved, as well as those that prevail in transportation, in storage, and on the market.

EFFECT OF ORCHARD CONDITIONS

MATURITY OF THE FRUIT

The maturity and color of the apples at picking time are very important factors in determining their susceptibility to scald, the more

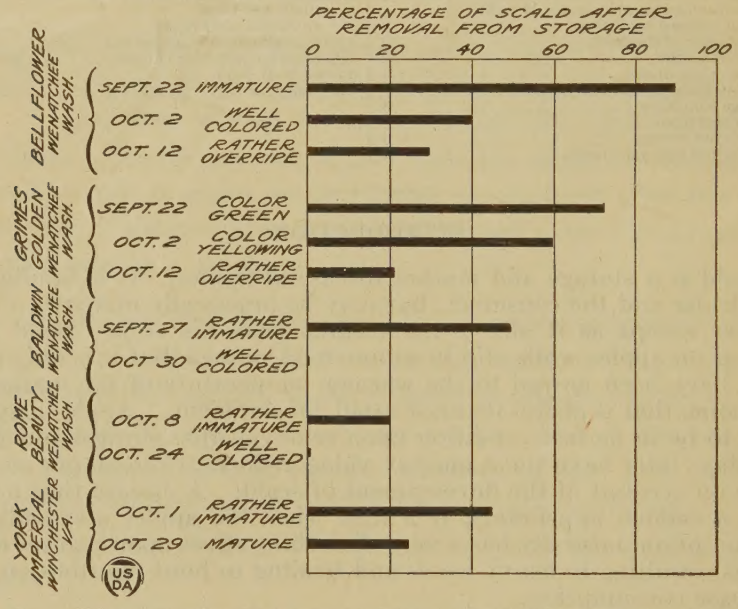

FIG. 1.—Effect of maturity of fruit upon development of scald after removal from storage. Notes on the Virginia apples were taken February 25 and on the Washington apples March 12 to 19

mature and better colored fruit scalding less than that which is greener. The effect of the time of picking upon the later development of scald is brought out in Figure 1.

The results varied widely in the different tests, but in general the fruit that was well matured but not overripe developed less than half as much scald as that which was picked green.

Color and maturity are influenced by the weather conditions, the pruning, the soil, the fertilizer, and the general orchard management, as well as by the time of picking. Good exposure to sunlight produces high color and makes the apples more resistant to scald. Heavy applications of nitrogenous fertilizers make the apples more susceptible to the disease.

SOIL MOISTURE

The effect of soil moisture upon the susceptibility of the fruit to scald can be tested most satisfactorily under irrigation conditions. Figure 2 gives the results of irrigation and storage experiments

made at Wenatchee, Wash. The apples from the heavily irrigated trees developed about three times as much scald after removal from storage as those from the lightly irrigated trees. It is impossible under nonirrigated conditions to control the amount of water supplied to the soil, but it is worth while to know that apples that have been forced either by heavy rains or by heavy irrigation have thereby become more susceptible to scald.

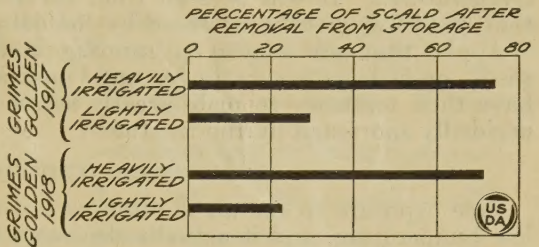

FIG. 2.—Influence of soil moisture upon the susceptibility of the fruit to apple scald

SIZE OF THE APPLES

In general, large apples are more susceptible to scald than small ones, but this difference in susceptibility is apparently not due so much to size in itself as to the forcing that induces the size and the immaturity and poor color that usually accompany it. Apples may develop a good size without becoming unduly susceptible to scald.

EFFECT OF PACKING-HOUSE, TRANSPORTATION, AND STORAGE CONDITIONS

The orchard and seasonal conditions modify the susceptibility of the fruit to scald, but the conditions that prevail after the apples are picked determine the extent to which this susceptibility will be expressed in actual scald. These various conditions are considered separately under the heads of "Temperature," "Aeration and ventilation," "Humidity," etc. Although the apples are removed from the tree, they are still alive and carrying on most of their life processes. They have been cut off from their original source of food and water and must be given conditions that will conserve their stored supplies and yet allow their life functions to proceed in a normal manner.

TEMPERATURE

Low temperature is the best means known of prolonging the life of the apple and is also a most important agency in delaying the development of scald. Figure 3 shows the results of storage experiments on eastern Grimes Golden and York Imperial apples at constant temperatures ranging from 32° to 50° F. An increase of 9 degrees in the storage temperature has resulted in two to three times as much scald upon removal from storage on a particular date. It will be seen from the two sets of data on the 1916 Grimes Golden that the effect of low temperature is that of delaying scald rather than preventing it, the disease being as serious at 32° F. at the end of 16 weeks as it was at 41° F. at the end of 12 weeks.

It is important that the apples be cooled as quickly as possible after picking. They should be delivered to the storage plant promptly, and the storage conditions should be such that there will be the least possible delay in bringing the fruit to the final storage temperature. Placing large quantities of warm fruit in a single room or pile results in delayed cooling and consequent increase in scald.

DELAYED STORAGE

Many serious losses from scald are the after effects of delayed storage. Figure 4 shows the contrast in scald between apples that were stored immediately in rooms held at 32° F. and others of the same lots that were delayed in the storage hallway or at outside temperatures. It will be seen from the relative length of the bars that scald was greatly increased by the delay.

Apples that are delayed in unrefrigerated cars, in closed packing sheds, or in large stacks under any condition are almost certain to have their tendency to scald greatly increased and their storage life decidedly shortened by the treatment.

AERATION AND VENTILATION

Free exposure to the air is often as important in scald control as low temperature, and it actually decreases the tendency of the fruit to scald instead of merely delaying the development of the disease

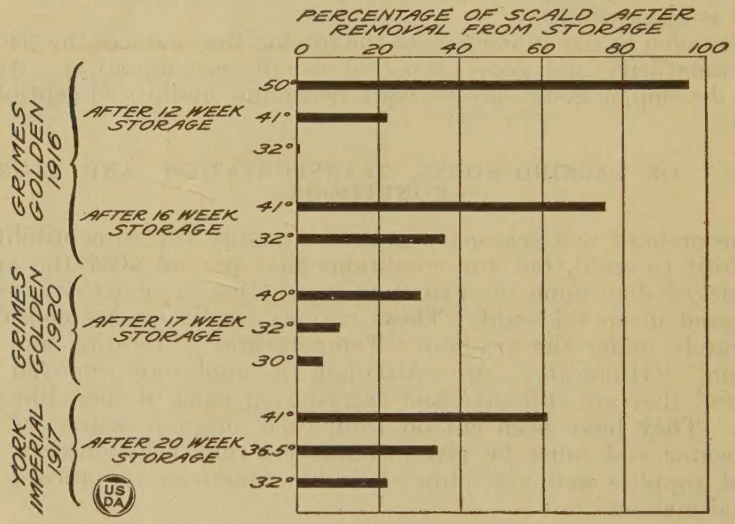

FIG. 3.—Effect of temperature upon apple scald

AERATION DURING DELAY

There is no other condition under which good air movement over the apples is so important as in cases of delayed storage. The serious damages resulting from delays at outside temperature are shown in Figure 4, while the possibility of turning misfortune into advantage and actually reducing scald by means of aeration during the delay is shown in Figure 5. There was little or no difference in the temperatures to which the different lots of fruit were exposed, but the delayed apples in the first case were almost entirely protected from air currents, while those described in Figure 5 had free exposure to the outside air. When immediate refrigeration is impossible, a great deal can be accomplished in scald control by keeping the apples in the shade and giving them the freest possible exposure to the air, but it should be borne in mind that delay in cooling is always favorable to the development of rots and always shortens the life of the apple.

AERATION IN THE STORAGE PLANT

Apples that are in the aisles or near the doors of the cold-storage rooms scald less than those that are located in the middle of the stacks. (Fig. 6.) Whatever contributes to the openness of the storage stacks and to the freedom of air movement over the apples is of value in scald control.

Apples often scald less in the cellar and in air-cooled storage than in commercial cold storage. When this occurs the benefits of the better air movement have outweighed the harmful effects of the higher temperatures in so far as scald is concerned. If storage

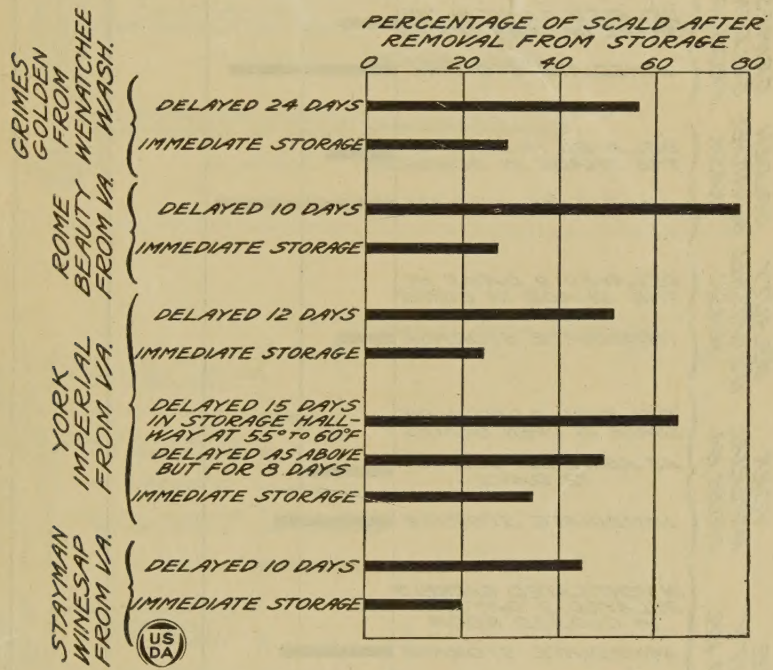

FIG. 4.—Effect of delayed cold storage upon the development of scald after removal from cold storage. The Grimes Golden apples were packed in boxes and the other varieties in barrels. The Grimes Golden and Rome Beauty were delayed in closed rooms, the Stayman Winesap and the first lot of York Imperial in a partly closed shed, and the second lot of York Imperial in the cold-storage hallway

cellars and air-cooled plants are tightly packed with fruit and but little attention is paid to ventilation, scald is likely to be extremely bad.

It is the aeration and the ventilation given during the first six or eight weeks of storage that are of greatest value in scald control. After this time the more susceptible varieties are liable to have developed a tendency to scald that ventilation can not correct.

VENTILATED PACKAGES

The effect of the openness of the package upon the development of scald is brought out in Figures 5, 6, 7, and 8. The tight barrels were those in ordinary use for apple packing, and the ventilated barrels differed from the tight ones in having 15 holes cut in the staves, each five-eighths of an inch wide by 4 inches long. The

baskets and hampers were of the types in most common use for apples, the baskets having overlapping slats, while the hampers had openings between the slats.

In general, there was less than half as much scald on the apples in the open packages as was found on those in the tight barrels, and with the Rhode Island Greening in hampers and the Stayman Winesap in baskets the contrast was even greater than this.

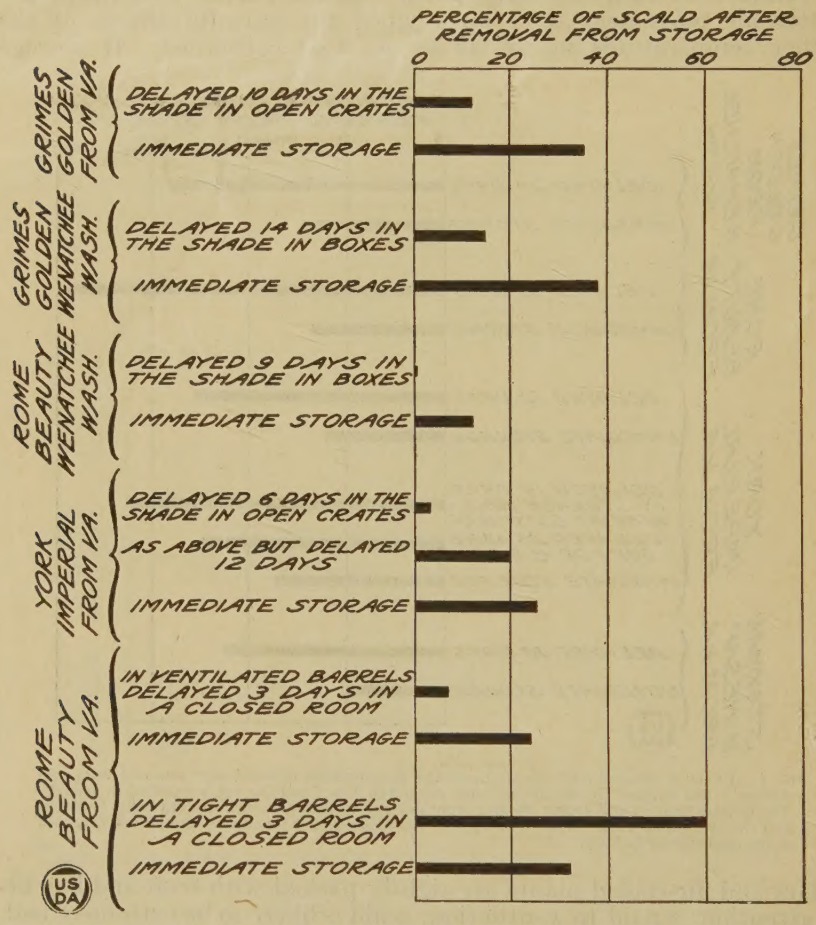
PERCENTAGE OF SCALD AFTER REMOVAL FROM STORAGE
0
20
40
60
80
GRIMES GOLDEN FROM VA.
DELAYED 10 DAYS IN THE SHADE IN OPEN CRATES
IMMEDIATE STORAGE
GRIMES GOLDEN WENATCHEE WASH.
DELAYED 14 DAYS IN THE SHADE IN BOXES
IMMEDIATE STORAGE
ROME BEAUTY WENATCHEE WASH.
DELAYED 9 DAYS IN THE SHADE IN BOXES
IMMEDIATE STORAGE
YORK IMPERIAL FROM VA.
DELAYED 6 DAYS IN THE SHADE IN OPEN CRATES
AS ABOVE BUT DELAYED 12 DAYS
IMMEDIATE STORAGE
ROME BEAUTY FROM VA.
IN VENTILATED BARRELS DELAYED 3 DAYS IN A CLOSED ROOM
IMMEDIATE STORAGE
IN TIGHT BARRELS DELAYED 3 DAYS IN A CLOSED ROOM
IMMEDIATE STORAGE
USDA

FIG. 5.—Effect of aeration during the delayed storage upon the development of scald after removal from cold storage

The apples in the ventilated packages cool more quickly in storage than those in the tight ones, and this in itself is of value in scald control as well as in the prevention of rots and the conservation of the life of the apple; but the greatest value of the open package so far as scald is concerned lies in the free exposure of the apples to the air.

Apples also usually scald less in boxes than in barrels, but boxes are often stacked so tightly that the value of their openness is largely lost, while this can not be readily done with the hamper.

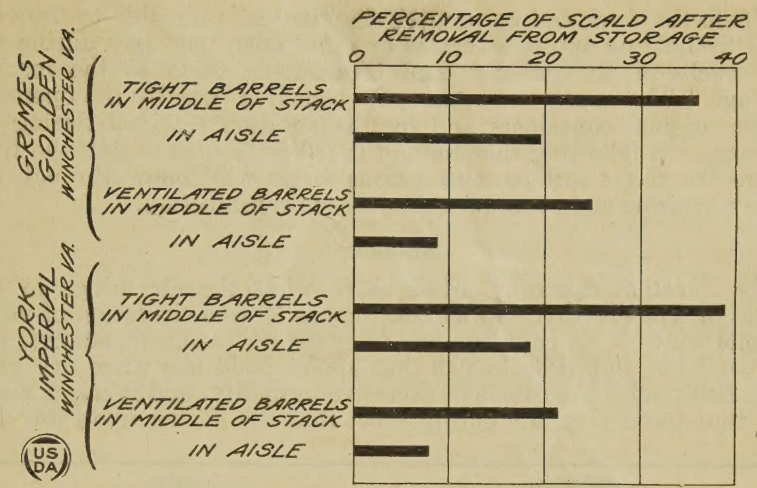

FIG. 6.—Effect of location in the storage room upon development of scald after removal from cold storage

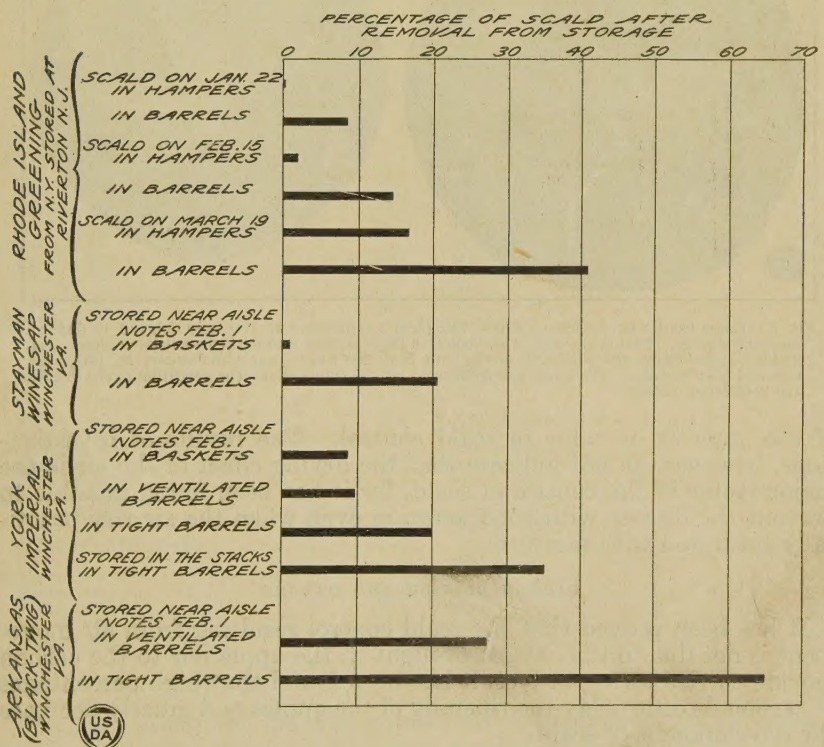

FIG. 7.—Effect of openness of storage package upon development of scald after removal from cold storage

Where the work can be properly handled it is possible to decrease scald by holding apples in crates or other open packages during the first weeks of storage and then transferring them to the market package. The apples are apparently benefited both by the openness of the original containers and by the aeration received during repacking. In following this method it is essential to repack the fruit before the tissue softens, else serious losses will follow through excessive bruising and consequent increase in rot infection.

HUMIDITY

The question naturally arises as to what the air brings to the apples or what it carries away that makes its free ciculation of value in scald control. A complete and final answer to this question is not yet available, but it is known that apples scald less when dry than when held under conditions of excessive humidity, and it seems probable that the drying and curing effect that the air has upon the skin

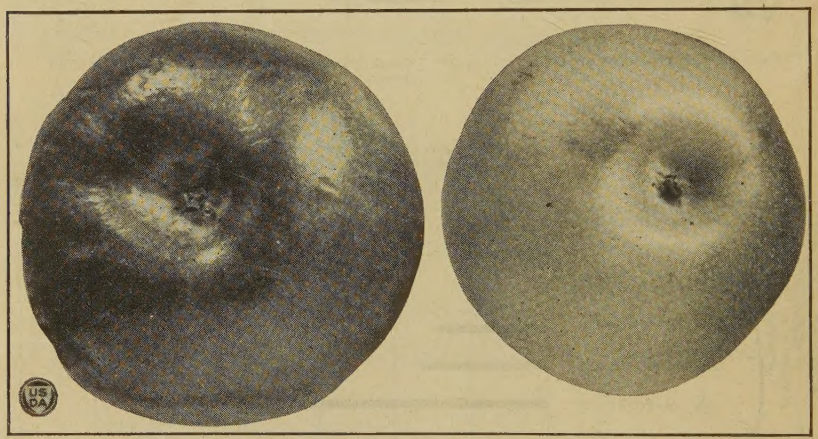

FIG. 8.—Rome beauty apples from Vienna, Va., picked September 27, 1918, and delayed 10 days in reaching storage. Part of the fruit was packed in tight barrels and part in ventilated ones. The scalded apple shows the condition of the fruit from the tight barrels on January 28, 1919, after removal from storage. The apple free from scald (at the right) shows the condition of the fruit in the ventilated barrels

of the apple is of value in scald control. The results of investigations, however, do not indicate that the drying effect of the air is the major factor in the control of scald, for it has been found possible to prevent the disease with good aeration even when the air was practically saturated with moisture.

CARBON DIOXIDE AND OXYGEN

It has been proved that the scald control resulting from air movement is not due to the oxygen brought to the apple nor to the carbon dioxide carried away; in fact, it has been found that high percentages of carbon dioxide delay the ripening of the apples and greatly decrease the development of scald.

ODOROUS SUBSTANCES

It is known that certain of the various substances that produce the odor of the apple may become definitely harmful to it when present

in great concentration and that the injuries produced are similar to scald in appearance. It seems probable that the value of aeration in scald control is largely due to the removal of these odorous products thrown off by the apple.

SCALD CONTROL BY OILED PAPER

OILED WRAPPERS

A most efficient and practicable method of scald control is to be found in the use of oiled-paper wrappers. Table 1 shows the results of tests covering five years on commercial lots of apples in the East and in the Pacific Northwest. The western apples were packed in boxes and the eastern ones in barrels. The results show the efficiency of the oiled wrapper under both box and barrel conditions, but it should be noted that it is not considered practicable to pack wrapped fruit in barrels.

TABLE 1.—*Effect of oiled wrappers on development of scald as shown by records taken after removal of the apples from cold storage*

Variety and date of note taking	Degree of scald (per cent)	
	Oiled wrappers	Unoiled wrappers or unwrapped
EASTERN APPLES		
Grimes Golden:		
Jan. 20, 1919	0	27
Jan. 13, 1920	0	83
Jan. 8, 1921	0	66
Jan. 19, 1922	0	35
Jan. 12, 1923	.1	42
York Imperial:		
Jan. 15, 1920	0	70
May 14, 1921	0	89
Feb. 10, 1922	2.4	8
Feb. 17, 1923	.6	31
Stayman Winesap:		
May 14, 1921	0	26
Feb. 13, 1922	9.7	52
Feb. 26, 1923	7.2	22
Arkansas:		
Jan. 10, 1920	.5	38
Feb. 24, 1921	.7	48
Feb. 21, 1923	4.6	70
Rhode Island Greening:		
Mar. 19, 1921	0	21
Mar. 29, 1922	1	28
Yellow Newtown:		
Mar. 12, 1920	0	15
NORTHWESTERN APPLES		
Grimes Golden:		
Feb. 5, 1920	0	15
Feb. 12, 1921	0	25
Mar. 1, 1922	0	31
Feb. 17, 1923	.6	36
NORTHWESTERN APPLES—continued		
York Imperial:		
Apr. 22, 1922	0.4	47
Apr. 19, 1923	.9	51
Stayman Winesap:		
Mar. 24, 1919	0	19
May 23, 1921	0	16
Mar. 18, 1922	.7	16
May 4, 1923	0	24
Delicious:		
Mar. 17, 1923	0	6
Rome Beauty:		
Apr. 30, 1920	0	41
May 18, 1921	0	30
Apr. 22, 1922	0	22
May 4, 1923	0	30
Arkansas:		
May 17, 1921	0	23
June 7, 1922	7	17
June 6, 1923	3	45
White Pearmain:		
June 7, 1922	0	29
Apr. 3, 1923	0	12
Arkansas Black:		
June 20, 1921	0	9
June 14, 1922	.3	7
June 8, 1923	0	5
Yellow Newtown:		
June 14, 1922	3	33
Winesap:		
June 20, 1921	0	9
June 14, 1922	0	30
May 26, 1923	0	6

The oiled wrappers did not completely control scald in all cases, but they held the disease in check to a remarkable degree and to an extent that materially affected the market value of the fruit. Under average market conditions 5 per cent of scald on the box apples or

10 per cent on the barrel apples would be liable to mean a discount in price, and 25 per cent of scald on the box apples or 50 per cent on the barrel apples would be likely to result in the market price being cut 25 per cent or more. It will be seen that at the time of note taking nearly all of the apples that were unwrapped or in unoiled wrappers had a much depreciated market value on account of scald, while those in oiled wrappers were either entirely free from the disease or so nearly free that their market value was but little affected. The comparative condition of the Yellow Newtown under the two methods of packing is shown in Figure 9.

The oiled wrappers have also been tested on apples that were held in cellar and air-cooled storage and on others that were delayed in reaching cold storage. Under all these conditions they have either entirely controlled scald or greatly reduced it. The oiled wrapper has shown to a great advantage in after-storage shipments of fruit. Figure 10 shows the comparative condition of Grimes Golden in oiled and unoiled wrappers after shipment across the continent by ordinary express.

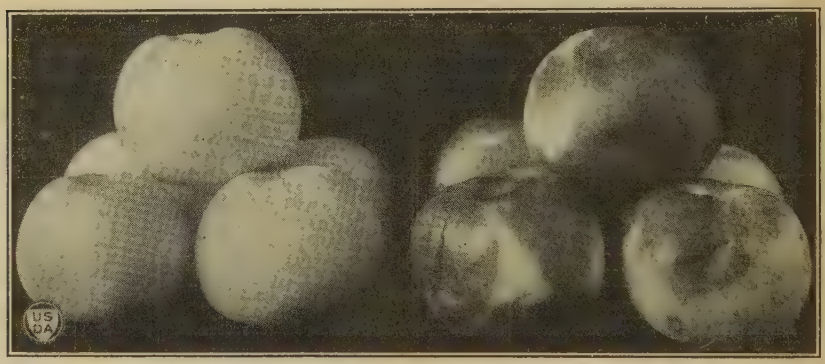

FIG. 9.—Yellow Newtown apples from Winchester, Va., picked on September 30, 1919, photographed July 1, 1920. The apples on the left were in oiled wrappers, while those on the right were unwrapped

The scald control obtained with the oiled wrappers has been largely in the nature of removing the tendency to scald rather than merely delaying the development of the disease. Figure 11 shows the development of scald at various times during the storage season on eastern apples that were held in oiled wrappers and on similar apples that were unwrapped. Scald made some increase on the fruit in oiled wrappers as the season advanced, but very much less than it made on the unwrapped fruit. In all cases there was less scald on the apples in oiled wrappers toward the end of the storage season than was found on the unwrapped fruit three months earlier.

The Arkansas (*Mammoth Black Twig*)[1] has given greater difficulty in scald control than any other variety tested. In two out of the six tests that have been combined to make the average for the variety as shown in Figure 11, the apples in oiled wrappers showed enough scald by the middle of February to affect their selling price, and by the middle of April a third of the oiled-wrapper

[1] Some of the fruit included under the name of this variety may have been the Paragon, a variety indistinguishable from the Arkansas in the trade, very similar to it both in its habits of growth and in its keeping qualities, and so far as the writers have observed similar in its susceptibility to scald.

lots had moved up to this point; but the three other lots remained practically free from scald, and the average scald for the six lots in oiled wrappers on April 15 was less than half as much as was found on the unwrapped fruit three months earlier. These results with the eastern-grown Arkansas are the poorest that have been obtained in a total of more than 80 different commercial tests with oiled wrappers.

The oiled wrapper must carry at least 15 per cent of its finished weight in odorless, tasteless mineral oil if it is to give satisfactory scald control, and 18 to 20 per cent of oil is desirable. Still higher percentages of oil (25 to 35 per cent) probably add something to the efficiency of the paper and in so far as they have been tested have not been found harmful to the apples.

FIG. 10.—Grimes Golden apples removed from cold storage at Wenatchee, Wash., February 13, 1923, shipped in small lot by warm express to Washington, D. C., arriving February 20; in cold storage February 21 to 26; in warm room for exhibition purposes from February 26 to March 1; photographed March 1

SHREDDED OILED PAPER

In the barrel package shredded oiled paper takes the place of the oiled wrapper. The paper should be cut so as to be readily scattered in the barrel. Strips about 5 inches long and three-eighths of an inch wide have met with rather general approval among growers.

A paper that is somewhat resilient and springy is better than one that is soft and inclined to mat. It is easier to shake apart after it has been baled, and when thrown into the barrel it has a greater tendency to spread out between the apples and give the maximum contact with them. Like the oiled wrapper, the shredded oiled paper must carry at least 15 per cent of its weight in odorless, tasteless mineral oil.

If evenly distributed, 1½ pounds of paper to the barrel is sufficient to give satisfactory scald control. Two pounds has sometimes given better results, but it is doubtful if under average conditions the additional scald control from using this quantity of paper would be sufficient to justify the extra cost. One pound of shredded paper to

the barrel is not sufficient to give satisfactory scald control under average conditions.

With 1½ pounds of paper well distributed in the barrel, and with proper shaking, a barrel of apples weighs approximately 1½ pounds more than a barrel similarly packed but without the paper. The shredded paper makes no appreciable decrease in the number of apples to the barrel.

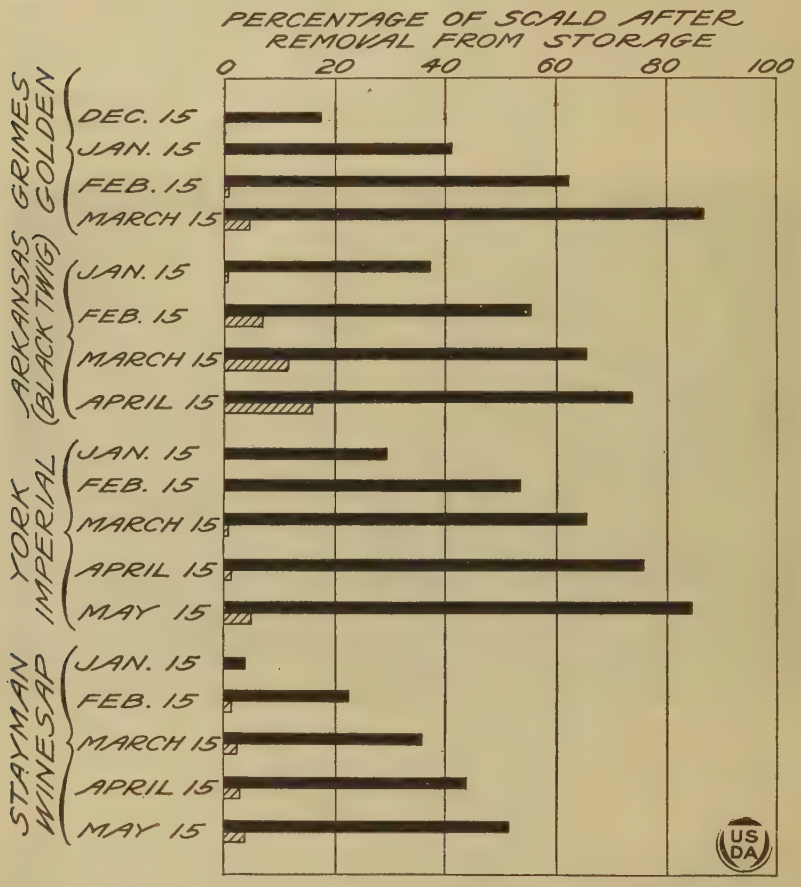

FIG. 11.—A comparison of scald on apples in oiled wrappers with that on unwrapped apples at various times in the storage season. The results shown are the average for experiments covering five years and include tests on four different lots of Stayman Winesap, nine different lots of York Imperial, and six different lots each of Grimes Golden and Arkansas. The degree of scald on the unwrapped fruit is indicated by the solid bar and that on the fruit in oiled wrappers by the shaded bar

SCALD CONTROL IN THE BARREL PACKAGE

The results of 19 different tests with shredded paper, covering 7 different varieties, are shown in Table 2 and in Figure 12. The records were taken after the fruit had been out of storage and in a warm room for three days. The percentages are based on the number of apples having sufficient scald to be discriminated against on the market, the apples having mere traces or touches of scald not being included.

It will be seen that in the untreated barrels from 24 to 96 per cent of the apples were scalded, whereas in those having shredded oiled paper there were but three instances where more than 7 per cent of the apples were scalded, and there were eight instances where they were entirely free from scald. On the untreated apples the average percentage of scald was 67, whereas on the apples with shredded paper the average was 4. The reduction in the disease from the use of the shredded paper is very significant.

The experiments of Table 2 were all made on barrel apples. Tests have also been made with apples in hampers, baskets, and boxes with equally good or somewhat better success in scald control.

DISTRIBUTION OF PAPER IN THE BARREL

In the experiments reported in Table 2 the shredded paper was well distributed in the barrel, practically every apple coming in contact with the paper. Other tests were made where several layers of apples were run in between the layers of paper, resulting in many apples being entirely out of contact with the paper. A part of these tests were made in connection with the tests reported in Table 2 and part as independent experiments. The results are shown in Table 3 and also in Figure 12.

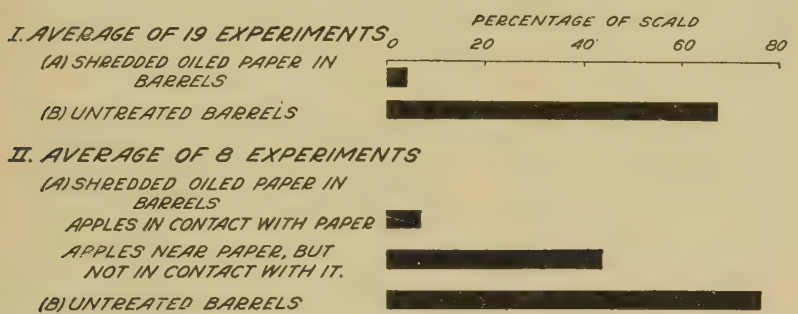

FIG. 12.—Results of experiments in the control of apple scald with shredded oiled paper

In two instances the development of scald on the apples that were in the barrels with shredded paper but out of contact with the paper was little different from that on the apples in the untreated barrels, but in the other five cases scald was decidedly reduced on the apples in barrels with paper even when out of contact with the paper.

As compared with the apples in contact with the paper, the scald control on those out of contact with it but near it was a decided failure. The average for the seven tests gives 7 per cent of scald on the apples in contact with the paper, 43 per cent on the apples of the same barrels that were near the paper but not in contact with it, and 76 per cent for the apples in the untreated barrels.

The results show that careful and thorough distribution of the paper is essential to good scald control. It is also a decidedly vital matter in the success of the shredded-paper treatment in general. If packages that are offered on the market as containing shredded paper are found to have 40 per cent or more of the apples scalded in certain parts of the barrel, the price is liable to be set on the basis of the poorest rather than the best of the apples and the conclusion

drawn that the shredded paper has added nothing to the market value of the fruit.

TABLE 2.—*Tests in the control of scald in barrel apples with shredded oiled paper*

Variety	Locality	Date of picking	Date of note taking	Percentage of apples scalded	
				Packed with paper	No paper
Grimes Golden	Rockville, Md	Sept. 13, 1923	Jan. 15, 1924	4	73
Do	Arlington farm Va	Sept. 11, 1924	Jan. 25, 1925	7	93
Do	Charleston, W. Va	Sept. 11, 1925	Jan. 16, 1926	17	77
York Imperial	Vienna, Va	Oct. 11, 1923	Apr. 3, 1924	6	70
Do	Rockville, Md	Oct. 18, 1923	Feb. 29, 1924	1	94
Do	do	Oct. 17, 1924	Apr. 2, 1925	0	25
Do	Winchester, Va		Mar. 26, 1925	0	35
Do	do		Mar. 5, 1926	11	95
Do	Rockville, Md	Oct. 23, 1925	Mar. 16, 1926	0	32
Do	Winchester, Va		Mar. 26, 1926	2	62
Stayman Winesap	Inwood, W. Va	Oct. 9, 1924	Feb. 27, 1925	0	96
Do	Rockville, Md	Oct. 6, 1925	Mar. 15, 1926	0	24
Rhode Island Greening	Albion, N. Y		Mar. 19, 1926	1	69
Arkansas	Inwood, W. Va	Oct. 29, 1923	Mar. 17, 1924	4	79
Do	do	Oct. 24, 1924	Feb. 28, 1925	0	91
Do	Woodside, Del	Oct. 13, 1925	Mar. 16, 1926	1	95
Do	Inwood, W. Va		Mar. 26, 1926	23	93
Yellow Newtown	Hurds, Va	Sept. 17, 1924	June 18, 1925	0	28
Ben Davis	Inwood, W. Va	Oct. 29, 1923	May 20, 1924	0	45
Average				4	67

TABLE 3.—*Results with poor distribution of shredded oiled paper in barrels of apples*

Variety	Locality	Date of picking	Date of note taking	Percentage of apples scalded		
				Paper in barrels		Barrels with no paper
				Apples in contact with paper	Apples having no contact with paper	
York Imperial	Winchester, Va		Mar. 5, 1926	11	43	95
Do	do		Mar. 26, 1926	5	58	62
Stayman Winesap	Inwood, W. Va	Oct. 9, 1924	Feb. 27, 1925	2	53	96
Arkansas	do	Oct. 24, 1924	Feb. 28, 1925	0	27	91
Do	do		Mar. 26, 1926	22	58	93
Do	Havre de Grace, Md		May 21, 1926	12	67	
Yellow Newtown	Hurds, Va	Sept. 17, 1924	June 18, 1925	0	21	28
Rhode Island Greening	Albion, N. Y		Mar. 19, 1926	2	20	69
Average				7	43	76

One of the greatest obstacles in the control of scald with shredded oiled paper is the rather common habit with growers and packers of running a large quantity of apples into the barrels at one time. This is done for the sake of speed and because of the rush of work during the packing season, but it precludes the successful use of the shredded paper. If the paper is to be scattered over the apples only between the runs, good scald control requires that not more than two layers of apples across the barrel should be run in at one time, and if the

variety is particularly susceptible to scald, one layer of apples at a time is much to be preferred. Small runs and frequent shaking have a value, aside from the control of scald, in the way of producing a tighter pack that is less likely to require plugging later in the season.

The shredded paper must always be shaken apart before being thrown into the barrel. Large mats and heavy layers of paper not only prevent the paper from having its full efficiency in scald control but also give a temporary bridging effect that results in the barrel becoming slack later in the season.

The face layers of apples should receive their share of the oiled paper. There should be a layer of paper between the face layer of apples and the corrugated cap. The writers have seen instances where the face layers were left without paper and where scald was confined almost entirely to these layers.

CRITICAL PERIODS IN SCALD CONTROL

The life of the stored apple may be divided into four different periods or stages with reference to the development of scald.

The first period begins with the picking of the fruit and, with the more susceptible varieties, ends with the sixth or eighth week of storage. During this time the scald-producing agencies are apparently most active, yet up to the end of the period it is possible largely or entirely to overcome any accumulated tendencies to the disease by placing the apples in oiled paper or by giving them a very thorough airing.

The second stage in the development of scald extends over a period of five to eight weeks following the first period. Preventive measures now become of little or no avail. The apples may be destined to scald if given sufficient time, yet if removed from storage before the end of the five to eight weeks they do not show scald, even upon warming. If the apples are consumed before the end of this second period the scald problem is avoided.

The third period starts with the end of the second period and covers the remainder of the time fruit is in storage. The apples now become latently or potentially scalded; certain skin cells are practically dead, yet they remain green and appear normal if not exposed to warm air.

The fourth period includes the life of the apple after its removal from storage and exposure to warmer air. The affected skin turns brown and completes its death processes. The apple is deprived of its protective skin layer and soon becomes the victim of apple rots.

AFTER-STORAGE BEHAVIOR OF APPLES

If the storage rooms are opened but little and the temperature is held constantly at 32° F., apple scald may not become evident until the apples are removed from storage. Its rate of development after removal will depend upon the temperature to which the fruit is exposed. During the winter months the apples are often passed on to the consumer before the scald becomes seriously evident, but during the spring months, especially the later ones, the disease is likely to develop in transit or on the market.

In many of the experiments previously reported a record was kept of the condition of the fruit at the time of its removal from storage as well as its condition after it had become warm. The results are

shown in Table 4. It will be seen that apples which showed no scald while still in storage often became badly scalded a few days after removal, and that those showing scald in storage had the disease greatly intensified by exposure to the warm air.

TABLE 4.—*Development of scald after the removal of apples from storage*

[The apples had not received ventilation or oiled-wrapper treatment. The eastern apples were held for 3 days at 70° F. and the northwestern apples for 7 to 10 days at 55° to 60° F. before the second inspection]

Variety and date of removal from storage	Degree of scald (per cent)		Variety and date of removal from storage	Degree of scald (per cent)	
	Upon removal from storage	After fruit had become warm		Upon removal from storage	After fruit had become warm
EASTERN APPLES			NORTHWESTERN APPLES—continued		
Grimes Golden:			Yellow Bellflower:		
Dec. 18, 1917	0	48	Feb. 6, 1919	0	15
Jan. 12, 1923	3	42	York Imperial:		
York Imperial:			Apr. 12, 1922	12	47
Feb. 1, 1921	0	38	Apr. 6, 1923	5	51
Feb. 26, 1923	4	46	Stayman Winesap:		
Stayman Winesap:			Mar. 17, 1919	0	19
Feb. 26, 1923	2	22	May 4, 1921	4	16
Arkansas:			Mar. 7, 1923	3	15
Feb. 24, 1921	0	48	Arkansas:		
Feb. 17, 1923	11	75	May 4, 1921	19	23
NORTHWESTERN APPLES			June 2, 1922	12	17
			Rome Beauty:		
Grimes Golden:			Mar. 17, 1919	0	11
Feb. 6, 1919	0	35	Apr. 14, 1921	2	22
Feb. 1, 1921	0	25	Winesap:		
Feb. 10, 1922	5	31	June 10, 1921	2	9
Feb. 5, 1923	3	36	June 10, 1922	10	30

LOSSES FROM SCALD

Market inspection reports show apple scald as a close second to blue mold in the losses on apples not protected with oiled paper. From the middle of December till the close of the apple season one may find apples offered at 10 to 40 per cent discount on account of scald. The depreciated price may be entirely due to the bad condition of the fruit at the time of sale, but it is often to be partly attributed to fear that the disease will become rapidly worse. When scald begins to appear in commercial storage lots the dealer knows that the fruit can not safely be held for more favorable prices, and it is usually moved to market and sold for what it will bring. The losses and spoilage from scald vary with the season, the city, and the abundance of the crop. More scald is evident on southern markets than on northern ones, more during warm periods than during cool ones, and more in a year when the fruit moves slowly than when there is a ready sale.

Besides the wastage of fruit and the depreciation in price resulting from scald, there are general effects upon distribution and consumption that are distinct handicaps to the apple industry. The disease is a limiting factor in distribution to smaller centers and in after-storage shipments in general. The apples that are rushed through the market as scald begins to develop often become badly scalded on the hands of the consumer, not only causing him a direct loss but also preventing him from continuing as a free buyer of apples.

SUMMARY

Susceptibility to scald varies with the season and with orchard conditions and management. Early picked and poorly colored fruit is extremely susceptible to scald, while well-colored, well-matured apples are more resistant to the disease.

Low temperature and prompt cooling are of first importance in delaying the development of scald.

Aeration is a preventive of scald, the success of the treatment varying with the thoroughness with which it can be carried out. Aeration during delayed storage is particularly important and valuable.

Storing the fruit in hampers, ventilated barrels, or baskets decreases the development of scald. Conversely, storing it in tight barrels and tight stacks favors the development of the disease.

Oiled-paper wrappers are the most complete preventive of scald that has been found. They have eliminated the disease as a market factor in all but 2 of the 80 commercial tests that have been made.

When properly handled, shredded oiled paper has given practically as good scald control as the oiled wrappers, but the paper must be well distributed in the package.

ORGANIZATION OF THE UNITED STATES DEPARTMENT OF AGRICULTURE

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